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# ANNUAL ADDRESS

TO THE

# Birmingham
# Natural History & Microscopical Society,

*BY THE RETIRING PRESIDENT,*

SAML. ALLPORT, F.G.S.

1869.

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# ADDRESS.

Gentlemen,

When you conferred upon me the honour of electing me your Preſident, it was, I believe, the wiſh of ſome among you to give rather more prominence to geological ſtudies; and as it is now my duty, as well as pleaſure, to addreſs you on retiring from office, it will, perhaps, be expected that the ſubject of my diſcourſe ſhould bear, more or leſs cloſely, on GEOLOGY, or the allied ſciences. I will, therefore, avail myſelf of the opportunity to requeſt your attention to the conſideration of two or three queſtions, which have recently received a conſiderable amount of diſcuſſion; and I ſhall ſelect them from different branches of the ſcience, in the hope that one or more of them may be of ſufficient intereſt to lead to further inquiry and ſtudy on the part of ſome of our members.

A ſubject of great intereſt and importance, which has not received much attention from Engliſh geologiſts, is *Petrology*, including under that term the ſtudy of the mode of formation, claſſification, chemical and mineralogical compoſition of rocks. On none of theſe ſubjects have we a ſatisfactory work in our language; in fact, the ſtudy of rock-maſſes is quite in its infancy in this country, the attention of our leading geologiſts having been hitherto almoſt excluſively directed to their ſtratigraphical relations, and the ſtill greater attractions of palæontological reſearch. It ſhould be remembered, however, that the exiſtence of geology as a true ſcience is of ſuch recent date that ſome of its earlieſt profeſſors are ſtill living among us; like other new ſubjects of inquiry, it has ſuffered much from that bane of ſcience, haſty generalization, and much of the work of the future will conſiſt in clearing from our path the rubbiſh left there by ſuch theoriſts as the *Neptuniſts* and *Plutoniſts* of early geological days. If the members of theſe rival ſchools had been content with theorizing, no great harm would have been done; but it unfortunately happens that when a man is poſſeſſed by a ſtrong theory, he is apt to ſelect his facts: he deſcribes things as they *ought* to be, and is thus, quite unconſciouſly, the cauſe of deceiving others as well as himſelf.

We have all read, for example, of the *fundamental granite;* that it forms the axis of moſt mountain chains, and ſo forth---but when we ſearch for it, it is not to be found in nature; in fact, nearly all granite is known to be of more recent age than thouſands of feet of ſedimentary rocks.

The queſtion of the origin of granite, and ſome other ſo-called igneous rocks, is ſtill far from ſettled. There is clear proof in ſome caſes of their igneous origin, while others plainly indicate that they were originally aqueous depoſits; and I am inclined to believe, therefore, that geologiſts will ultimately agree with Profeſſor Haughton, that we muſt abandon the igneous as the excluſive theory of the origin of granite. When a maſs of this rock is ſeen to be intruſive, and to ſend veins into the adjacent formations, it muſt be regarded as an igneous rock; on the other hand, when it is not intruſive, but is clearly interbedded with ſedimentary depoſits, and exhibits in itſelf a bedded ſtructure in the maſs, it may fairly be conſidered as of aqueous origin---a gneiſſic rock, in fact, the metamorphiſm of which has been carried a ſtep further.

As examples, I ſhould ſay the granites of Cornwall and the ſouth-eaſt of Ireland are igneous rocks, becauſe they have broken through and altered the adjacent Silurian or Devonian ſtrata;

and that thoſe of Donegal, the weſt of Scotland, and the Malvern Hills, are metamorphic rocks, becauſe they preſent a ſtratified ſtructure, are not intruſive, and are interbedded with depoſits of ſedimentary origin. Many of you are acquainted with the deſcription given in *Siluria*, of the ſtructure of the Malvern Hills, viz., that it conſiſts of a central eruptive axis of igneous rocks, flanked on both ſides by highly altered ſedimentary depoſits, which gradually become harder as they approach the central ridge. Dr. Holl has, however, deſcribed theſe hills as compoſed of a thick ſeries of cryſtalline metamorphic rocks, having a general ſtrike acroſs the chain; the whole having been metamorphoſed and diſturbed before the depoſition of the Lower Silurian rocks, which are ſeen to reſt on the upturned edges of the former. As theſe two accounts are utterly irreconcileable with each other, one of the two at leaſt muſt be wrong; and I think no geologiſt, with an unbiaſſed mind, who had examined the diſtrict, would heſitate to ſay that the former is completely at variance with the facts. It ſupplies, therefore, a good illuſtration of a deſcription written under the influence of a theory. An obſerver paſſing along the chain of hills, from ſouth to north, cannot fail to perceive that he is croſſing a great ſeries of metamorphic rocks, ſuch as hornblend-ſchiſt, mica-ſchiſt, and gneiſſoid rocks which have been tilted at high angles, and are occaſionally traverſed by trap dykes of a later age. In the north hill, the rocks certainly have a more amorphous and granitoid ſtructure, but, ſtill, the original bedding can frequently be made out.

I have collected ſpecimens of the various rocks from all the hills, and a microſcopical examination of numerous ſections fully confirms the evidence obtained in the field as to their ſedimentary origin.

The queſtion of the origin of many rocks is rendered difficult by the fact that they have all undergone more or leſs alteration ſubſequently to their conſolidation; a circumſtance which deſerves more attention than it has hitherto received. It has been long known that minerals are not unfrequently found with definite forms, which do not belong to the ſubſtances of which thoſe minerals now conſiſt; and the origin of theſe pſeudomorphs, as they are called, is in many caſes eaſily explained; but it appears to have been overlooked by moſt writers, that, if ſingle cryſtals can be completely metamorphoſed, rock-maſſes may alſo be ſimilarly affected.

That ſuch changes have occurred is certain, and they may be detected by examining thin ſections of rocks with the polarizing microſcope; for theſe pſeudomorphs are merely aggregates of mineral matter, which has been depoſited ſimultaneouſly with the removal of that which poſſeſſed the original cryſtal-form. And, as I have ſhown in a former paper, the action of ſuch a compound maſs on polarized light differs extremely from the uniform action of a ſingle cryſtal of ſimple ſtructure.

The chief agent in the production of theſe changes is, undoubtedly, water. To whatever depth we penetrate, it is invariably preſent, not only in the joints and fiſſures, but permeating the ſolid rock itſelf. You are all familiar with the fact, that ſtones juſt raiſed from the quarry are ſoft, and eaſily worked, ſome are almoſt plaſtic, but ſet, and become harder when dry. Now not only ſandſtones, but hard, compact, cryſtalline rocks alſo contain water in every part. Break a piece of *Rowley* baſalt from a maſs in the quarry, and you will find that it loſes water, and, when dry, aſſumes a lighter colour. The occurrence, however, in this rock of cryſtallized carbonate of lime and hydrated ſilicates called zeolites, affords concluſive proof of the preſence of water containing various ſubſtances in ſolution. Some of theſe old *Plutonic* rocks, and eſpecially the amygdaloidal traps, were originally ſcoriaceous or cellular, like the lavas of recent volcanos, but are now frequently found to be ſolid throughout, the cavities having been gradually filled up by the ſubſequent infiltration of mineral matter held in ſolution. Many of my ſections exhibit this very clearly; they demonſtrate, moreover, that theſe extraneous minerals have been depoſited in ſucceſſive layers, and that occaſionally theſe layers vary in mineralogical compoſition.

As the temperature increaſes with the depth, ſo may the quantity of ſalts held in ſolution; and when a high temperature is attained, the chemical action exerted on the rocks muſt be greatly increaſed. When, therefore, we conſider that moſt rocks (in fact, all igneous rocks) are compoſed of ſilicates, and that ſuch compounds are readily acted on by alkaline carbonates, and by water containing carbonic acid, we perceive that at all depths conditions exist which are more or less favourable to the production of chemical changes, and the development or removal of minerals.

Perhaps it would be difficult to produce a better illuſtration of theſe changes than that afforded by the "*green rock*" of our coal field. It is a dolerite, differing only from the "*Rowley* rag" in the fact that it generally contains a greater proportion of a peculiar green mineral, which is in moſt caſes clearly a ſecondary formation. The rock in queſtion occurs in extenſive ſheets between the coal meaſures, and I have invariably found that it has been greatly altered near its junction with the coal or ſhales; the alteration extending from both ſurfaces inwards towards the centre. In cutting through one of theſe ſheets, the central portion is ſeen to be a dark green cryſtalline rock, but on approaching either ſurface it gradually becomes ſofter, is dull in appearance, aſſumes a lighter colour, and when within a foot or ſo of the ſhale it is nearly white. When this part of the rock is examined under the microſcope, it is found that the green mineral and the augite have been more or leſs completely removed, and replaced by carbonate of lime or other minerals, and that the felſpar is alſo partially decompoſed.

We have ſeen, then, that water has played an important part in altering both rocks and minerals, and we alſo know that the ſame element has been preſent during the formation of true igneous rocks, for we find it in the quartz of intruſive granite, and in the cavities of minerals ejected from Veſuvius. That it is an important agent in the eruptions of active volcanos is well known to all obſervers, and I am not aware of the exiſtence of any evidence whatever in favour of the notion of a dry igneous fuſion—it does not exiſt in nature. Time, however, will not allow me to purſue this intereſting ſubject any further; and I will now only add, that on this as on moſt ſubjects, the extreme men on both ſides appear to be wrong, and that to the combined operation of heat, water, and chemical action, modified by preſſure, is to be attributed the origin of ſome of the granites, and the metamorphiſm of the cryſtalline ſchiſts. I will venture to add my belief that much, if not the whole, of the difference now found to exiſt between the ſo-called *Plutonic* and the volcanic rocks, is due to the pſeudomorphic action to which the former have been expoſed during the long periods which have elapſed ſince their original formation. A microſcopical examination of many rocks has already ſupplied me with ſatisfactory evidence on this point, but much remains to be done; and at ſome future time I hope to lay before you the reſult of further inveſtigations.

Having recently called your attention to the importance of ſubmitting rocks to microſcopical examination, I will now only repeat that, by no other known method can a correct knowledge be gained of the mineralogical conſtitution of the compact or fine-grained varieties; and even as to the coarſe-grained rocks, of which the chief conſtituent minerals are perceptible to the unaided eye, there are many important facts to be learned. I have made many hundred ſections of rocks and minerals, and have very frequently detected in them numerous minute cryſtals of various kinds, and cavities containing both fluid and cryſtals; occaſionally they are ſo abundant as to form an appreciable proportion of the ſpecimen, ſufficient probably to account for ſome of the diſcrepancies found in chemical analyſis. Theſe, and many other facts relating to ſtructure and pſeudomorphiſm, can only be ſtudied with the aid of the microſcope, and the time cannot be far diſtant when the geologiſt and mineralogiſt will find that inſtrument as indiſpenſable to him as it has long been to the botaniſt and zoologiſt.

Perhaps one of the moſt intereſting and unexpected reſults of modern geological reſearch is the evidence we now have of former changes of climate in the northern and ſouthern hemiſpheres. Whether ſimilar changes have occurred in the tropical regions is, I think, extremely doubtful, notwithſtanding the very poſitive aſſertions of Profeſſor Agaſſiz that he has obtained deciſive proof of glacial action in many parts of Brazil, and even nearly under the equator. I am well acquainted with some of the depoſits which he calls glacial drift, and to my mind they preſent characters utterly unlike thoſe belonging to glacial depoſits on this ſide the Atlantic. He even ſuppoſes that the valley of the Amazon has been ſcooped out by an enormous glacier deſcending from the Andes. In ſhort, the American profeſſor made ſo many wonderful diſcoveries in that river in ſo very ſhort a time, that naturaliſts with moderately developed imaginative powers would rather like to ſee them confirmed before adopting them as articles of belief.

The prevalence of a glacial period at the cloſe of the tertiary and in the early part of the poſt-tertiary periods has been eſtabliſhed on evidence of the moſt ſatisfactory character. Over the whole of Europe as far ſouth as lat. 50°, and in North America to lat. 40°, are to be found boulders or large angular fragments of rocks, together with extenſive depoſits of gravel, ſand, and clay. This glacial drift is ſpread in irregular patches over the greater part of theſe iſlands, over-lying rocks of every age, from the lateſt tertiary to the loweſt cambrian, and has been obſerved at various heights, from the preſent ſea level up to an elevation of 2,000 feet, in North Wales. As regards the duration of this cold period, there is good evidence to ſhow that it came on gradually, continued through a long ſeries of ages, and then paſſed away as gradually as it came on. In order, however, to obtain a correct idea of the nature and extent of the changes which have taken place in the climatal conditions of this part of the world, it will be neceſſary to go back a ſtep or two in geological time; and as I ſhall preſently call your attention to ſome intereſting diſcoveries in beds of miocene age, it will be well to notice briefly the character of the fauna and flora exiſting at that period, as well as ſome of the phyſical conditions which then prevailed.

At Bovey Tracey in Devonſhire, in the Iſland of Mull and the N.E. of Ireland, and more extenſively on the Continent, we find a ſeries of ſtrata of the miocene or middle tertiary formation. Foſſil remains are abundant, and as some are marine and others of freſh water origin, we have ſatisfactory evidence as to the character of the plants and animals then exiſting. The marine mollusca are ſuch as are now found in ſouthern latitudes, while in the freſh water beds of Auvergne, &c., there are the remains of at leaſt 100 ſpecies of mammalia, including the elephant, giraffe, hippopotamus, &c., and aſſociated with them are ſome large crocodiles and tortoiſes. Remains of the quadrumana have alſo been found, one of which, the dryopithecus, belonging to the family of long-armed apes, muſt have equalled a man in ſtature. Large collections of foſſil plants have alſo been made from beds of this age, and the evidence afforded by the character of the entire fauna and flora is deciſive as to the prevalence of a warmer climate than that now belonging to the ſame latitudes.

During the ſame period the general phyſical conditions of this part of Europe differed as widely from thoſe which now obtain as did the plants and animals.

It was a period of intenſe igneous activity in the regions now forming Central France, Germany, Hungary, the North of Ireland, and Scotland. Some of the volcanic cones and lava-streams of Auvergne (of which we have recently had ſo vivid a deſcription by one of our members) belong to this age, for it has been found that ſubſequently to the depoſition of the lower beds of the freſh vater formation above referred to, eruptions broke out, lava and ſhes were ſpread over them, and in the upper part of the ſeries, eds of lacuſtrine origin frequently alternate with ſheets of lava or olcanic aſhes. To this age, alſo, belong the basalt of the Giant's Cauſeway, and other great maſſes of igneous rock in the north of reland, the Hebrides, and the weſt coaſt of Scotland. Mr. Geikie nd others have ſhown, that the long chain of baſaltic rocks, xtending at irregular intervals from the ſouth of Antrim along he weſt coaſt of Scotland to the Faroe Iſlands, were all erupted during a long interval in the later tertiary period, miocene plants aving been found under the baſalt at Ardtun Head in Mull, near Antrim in Ireland, and other places. That there was a long ontinuance of the volcanic action is certain from the great hickneſs of the ſucceſſive ſheets of igneous matter, which in one mountain alone, Ben More, reach a height of more than 3,000 eet. From this great volcanic ridge hundreds of trap dykes iverge in a ſouth eaſterly direction, becoming fewer as the iſtance from that maſs increaſes, yet extending to the coaſt of Yorkſhire. They cut through all the formations up to and including the chalk, and even traverſe the older portions of the ertiary volcanic rocks.

Extenſive depoſits belonging to the pliocene diviſion of the ertiaries are found in Norfolk, Suffolk, and Eſſex, where they are nown as the coraline, red, and Norwich crag. They contain an xtenſive ſeries of foſſil remains, which exhibit clear proof of a gradual change in the climate during the depoſition of the ſucceſſive beds; for in the loweſt ſtrata, Mediterranean and other outhern ſhells greatly predominate, while in the upper beds theſe diſappear, and arctic forms take their place. Not to trouble you with details, I may ſay that there is now ſatisfactory evidence to ſhow, that from the eocene to the miocene period, the now temperate regions of the northern hemiſphere enjoyed a warm climate, and that many of the plants and animals were ſimilar to thoſe which are now characteriſtic of ſub-tropical countries; that during the pliocene period there was a gradual diminution of temperature, and that ſubſequently the ſame regions were expoſed for unnumbered ages to the rigours of an exceedingly cold climate.

During the long pre-glacial warm period, what was the climate of the polar regions? That is a queſtion which could not have been anſwered a ſhort time ago. Recent diſcoveries have, however, revealed to us the unexpected fact that the polar regions themſelves have been ſubject to ſimilar viciſſitudes of climate. For this intereſting reſult we are mainly indebted to Profeſſor Heer, of Zurich, who has deſcribed a large number of foſſil plants from the north of Canada, Bankſland, North Greenland, Iceland, and Spitzbergen. Still more recently, Mr. Whymper has given the reſults of a journey undertaken by him to North Greenland in the ſummer of 1867, the object of which was to collect information on the geology and natural hiſtory of the coaſt.

The region in which theſe inveſtigations have been carried on extends from about 67° to 79° north latitude. In theſe Polar regions there are now no trees to be found, 67° being their northern limit. Northern Greenland is covered by an enormous glacier, leaving only a narrow ſtrip of coaſt free from ice; during the ſhort ſummer this glacier ſends into the ocean every year hundreds of icebergs, which are carried by a ſouth-weſt current to the coaſts of Labrador and Newfoundland. During the miocene period, the climate of theſe ſame arctic regions was of a totally different character. Where a few ſtunted ſhrubs, with moſſes and lichens, are now the prevailing forms, the land was then covered with luxuriant foreſts, in which flouriſhed many ſpecies of large-leaved oaks, the poplar, birch, and walnut; numerous ſpecies of the fir tribe, and trees allied to the cypreſs were alſo common. Even plane trees, the lime, and magnolia have been found in Spitzbergen in lat. 78°, trees which are now only ſeen in the warmer parts of the temperate zone. Of climbing plants, there is a ſpecies of ivy and three kinds of vines, while at leaſt nine large ferns have left their remains in beds which are now covered by fields of ice and ſnow.

Many ingenious hypotheſes have, from time to time, been advanced to account for theſe great changes of climate. One author ſuggeſts a diſplacement of the poles, another the paſſage of our ſolar ſyſtem through regions of varying temperature, and now Mr. Croll maintains that the explanation is to be found in the periodical variations in the eccentricity of the earth's elliptical orbit.

Before reſorting to great coſmical changes, it will be well to remember that the glacial period ſtill exiſts, and that boulders and boulder clay are ſtill being depoſited along the bottom of the Atlantic, in latitudes as far ſouth as thoſe in which we have evidence of ice action during the glacial epoch itſelf. It is well known that a great arctic current runs in a ſouth-weſterly direction from Spitzbergen to Greenland, and thence along the coaſt of Newfoundland; it carries with it immenſe numbers of icebergs, ſome of which have been ſeen as far ſouth as lat. 36°. Theſe icebergs are portions of glaciers, and have been ſeen loaded with large ſtones, gravel, &c., which of courſe ſink to the bottom as the berg melts. The region of the Atlantic between 44° and 52° weſt, and from 40° to 50° northwards, is never wholly free from heavy ice, ſo that portion of the ſea muſt be continually receiving drift depoſits reſembling in character thoſe on the preſent dry land.

That climate depends to a very great extent on the direction of ocean currents is evident, from the great difference which exiſts in the temperature of places in the ſame latitude, but on oppoſite ſides of the Atlantic. Mr. Campbell, for example, ſtates that the average temperature of Sydney, in Nova Scotia, may be taken at 41°; it is near the latitude of Rochelle, where the average temperature is 55°. The appearance of the country coincides, he ſays, with the climate---"It is very like Norway, very unlike La Rochelle in ſunny France." The reaſon of the marked difference in the vegetation is the climate, and that reſults from the direction of the arctic current, which brings a flotilla of ice that never ends.* We ſee then that the arctic current carries with it a cold climate, while the Gulf Stream, running in a north-eaſterly direction acroſs the Atlantic, carries the warm waters of the tropical regions to the north-weſt ſhores of Europe. It is evident, therefore, that with ſuch a diſtribution of ſea and land as would allow the Gulf Stream to continue its original weſterly courſe, we ſhould have a cold climate in the weſt of Europe. In other words, a ſubſidence of the Iſthmus of Panama to the extent of a few hundred feet only, would cauſe the warm waters of the Gulf Stream to flow on into the Pacific, and we ſhould be deprived of our preſent exceptionally mild climate.

It has been long known that theſe great phyſical changes have been accompanied by correſponding variations in the organic world; and as the exiſtence of plants and animals greatly depends on the external conditions by which they are ſurrounded, we might be able to explain many facts connected with the dying out of ſome forms, and their replacement by others, if we could trace back the entire ſeries of changes which have taken place. Unfortunately this cannot be done, owing to the extreme imperfection of the geological record. It is ſingular that the fragmentary character of the geological ſeries of ſtrata ſhould have been ſo generally overlooked. It has, however, been recently much inſiſted on by many writers; and I have not ſeen a more conciſe or forcible ſtatement of the fact than is to be found in a paper by Mr. Croll in the *Philoſophical Magazine* for November laſt, in which he endeavours to prove the exiſtence of ſeveral glacial periods, although they may have left no traces in the exiſting rocks. He ſays, "The records of geology in regard to former glacial epochs are not only imperfect, but this imperfection follows as a neceſſary conſequence from the principles of geology itſelf; there is not only a want of records, but a reaſon in the very nature of geological evidences why there is ſuch a want. It is on a land-ſurface that the principal traces of the action of ice during a glacial epoch are left. But where are all our ancient land-ſurfaces? They are not to be found. The total thickneſs of the ſtratified rocks of Great Britain is nearly fourteen miles. But from the top to the bottom of this enormous depoſit there is hardly a land-ſurface to be found. True, there are patches of old land-ſurfaces of a local character---as, for example, the dirt beds of Portland---but, with the exception of the coal beds, every general formation from top to bottom was found under water, and none but the under clays ever exiſted as a land-ſurface. The entire ſtratified rocks of the globe, with the exception of the coal beds and under clays, conſiſt almoſt entirely of a ſeries of old ſea-bottoms, with here and there a freſh water depoſit. It is true that all land-ſurfaces once exiſted as ſea-bottoms, but the ſtratified rocks conſiſt of a ſeries of old ſea-bottoms which never were land-ſurfaces."

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* *A Short American Tramp.*

That the above ſtatements are correct, will not I imagine be denied, and I think it muſt be evident that, if we have no old land-ſurfaces, or hardly any freſh water formations in the older rocks, we cannot poſſibly have any adequate idea of the extent or character of the fauna and flora which inhabited the dry land during the formation of the long ſeries of ſea-bottoms: we may poſſeſs evidence of the exiſtence of mammals and birds as far back as the triaſſic period, but the extreme rarity of their remains, and the wide intervals between their ſucceſſive appearances, ſupply additional proof of the fragmentary character of the record.

For example, the firſt evidence we have as yet of the exiſtence of mammalia, is in the new red ſandſtone, in one of the upper beds of which a few teeth have been found; paſſing the lias and the lower oolite, we have four ſpecies in the great oolite, and then in the purbeck beds of freſh water origin we ſuddenly meet with no less than fourteen ſpecies, the whole of which have been obtained from an area leſs than 500 ſquare yards in extent, and from a ſingle ſtratum only a few inches thick. Were it not therefore for this one thin bed we ſhould have no evidence whatever of the exiſtence of mammalia throughout all the long period between the great oolite and the lower tertiary. We find in fact, that the preſervation of a few inches of marl has ſupplied us with more evidence as to the inhabitants of the dry land, than the whole of the ſecondary rocks put together.

We have here then ſufficient reaſon why moſt of the connecting links between extinct and exiſting animals are not to be found, and the opponents to Mr. Darwin's views of the origin of ſpecies ought in fairneſs to acknowledge that the general abſence of ſuch forms is no proof whatever that they never exiſted, yet this is one of the ſtock arguments invariably urged againſt the theory of deſcent with variation from preëxiſting forms. It is continually aſſerted that the theory in queſtion receives no ſupport from geology, but like moſt of the objections hitherto put forward, it is founded on ignorance of the facts, or diſinclination to recognize them. Every palæontologiſt knows that numerous connecting links have been diſcovered, the number is continually increaſing, and there can be no reaſonable doubt that, as attention is now ſpecially devoted to the ſubject, there will ſoon be ſuch an accumulation of evidence as will effectually diſpoſe of that part of the queſtion. To a portion of that evidence I will now aſk your attention. In 1860, Profeſſor Owen publiſhed his work on Palæontology, and in that portion devoted to the mammalia, he deſcribes the great Iriſh elk as a true deer, intermediate between the fallow and reindeer. The cervus martialis, he alſo ſays, ſeems to have been an intermediate form between the reindeer and the elk. Again, ſpeaking of the mammalian life of the miocene period, he ſays, "One or two of the generic forms moſt frequent in the older tertiary ſtrata ſtill lingered on the earth, but the reſt of the eocene mammalia had been ſuperſeded by new forms, ſome of which preſent characters intermediate between thoſe of eocene and thoſe of pliocene genera." Here and elſewhere he alſo repeatedly calls attention to numerous inſtances of a more generaliſed character of organization in the extinct animals, as compared with the more ſpecialiſed forms of exiſting ſpecies.

In the laſt volume, juſt publiſhed, of his work on the anatomy of the vertebrates, there is ſtill further evidence in ſupport of the doctrine of derivation; and I will requeſt your attention for a moment to a brief ſtatement of his opinions on this point, as he is on matters of minor importance a rather bitter and unfair opponent of Mr. Darwin. After referring to his ſtudies in Paris and his early reſearches ſubſequently to his return, he ſays, "Theſe reſults of extenſive, patient, and unbiaſſed inductive reſearch ſwayed with me in rejecting the principle of direct or miraculous creation, and in recognizing a natural law or ſecondary cauſe as operative in the production of ſpecies in orderly ſucceſſion and progreſſion." Cuvier, he informs us, held that ſpecies were not permanent, and taught this truth as a fact eſtabliſhed inductively on a wide and well laid baſis of obſervation; he alſo held that ſpecies were made to alter by ſmall degrees, and that therefore traces of ſuch gradual modifications were due from the foſſil world. You ought, he ſaid, to be able to ſhow the intermediate forms between the palæotherium and exiſting hoofed quadrupeds.

The progreſs of palæontology ſince that time has brought to light many of theſe miſſing links, and among them no leſs than five have been diſcovered which connect palæotherium with the horſe.

The eocene palæotherium is allied to the exiſting tapir and rhinoceros, but is ſeparated by a wide interval from the now iſolated group to which the horſe and aſs belong; but the diſcovery of three foſſil genera and ſeveral ſpecies of intermediate forms has enabled us to connect the two groups by a regular ſeries of gradations.

Profeſſor Owen deſcribes the variations between the ſeveral forms, and after ſhowing that the intermediate gradations are ſufficient to eſtabliſh a paſſage from the one into the other, he ſays, "thus amply and ſatisfactorily has been fulfilled Cuvier's requſition of 1821." Of equal importance with the diſcovery of theſe foſſils, is the order in which they occur, for they did not exiſt as ſpecies during the ſame periods of time. Mr. Owen ſays, "The ſingle-hoofed horſe family cannot be traced further back than the pliocene period: the tridactyle ſpecies have not been found in ſtrata earlier than the miocene, and the heavier ſhort-legged ſpecies with three functional hoofs to each foot, belong to upper and middle eocenes. Thus the ſucceſſion in time accords with the gradational modifications by which palæotherium is linked on to equus." "If," he continues, "the alternative---ſpecies by miracle or by law?---be applied to theſe forms, I accept the latter without miſgiving, and recognize ſuch law as continuouſly operating throughout tertiary time."

Such, gentlemen, are the opinions of Profeſſor Owen. I have been careful to lay them before you, as they expreſs the mature convictions of an acknowledged leader of the ſafe, orthodox ſchool of Britiſh naturaliſts.

If Owen has proved the former exiſtence of ſpecific and generic connecting links, Mr. Huxley has lately ſhown that even the wide gap exiſting between the now diſtinct claſſes of birds and reptiles may partly be filled up. The queſtions which he ſet himſelf to anſwer were---1. Are any foſſil birds more reptilian than any of thoſe now living? 2. Are any foſſil reptiles more bird-like than living reptiles? He then proceeded to demonſtrate that as a matter of fact the oldeſt known bird does exhibit a cloſer approximation to reptilian ſtructure than any modern bird. And he alſo proved that many of the extinct reptiles were more like birds than any now living.*

It would be eaſy to add many more inſtances of theſe connecting links, but my object is ſimply to ſhow that ſuch forms are now well known, and that conſequently an objection which would be fatal if eſtabliſhed, has not a ſhadow of foundation in fact.

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* Lecture at the Royal Inſtitution, February, 1868.

The evidence which I have now laid before you has been derived from a careful ſtudy of the comparative anatomy of recent and foſſil ſpecies, and is therefore the moſt ſatisfactory we can have, but it is by no means the only evidence; and I regret that I can do no more than glance for a moment at the intereſting ſubject of the geographical diſtribution of animals. It is now well known that the animals whoſe remains are found in the upper tertiary and poſt-tertiary rocks are in all parts of the world cloſely allied to thoſe now living in the ſame regions. Many of you know this to be the caſe in the old world area; and in countries poſſeſſing ſuch peculiar faunæ as South America, Auſtralia, or New Zealand, the facts are preciſely the ſame. In South America at the preſent day we find ſloths, armadillos, ant eaters, &c.; and in the neweſt tertiaries the great ſloth-like animal the megatherium, and the great armadillo the glyptodon, &c. Now what meaning, I would aſk, have theſe facts? Can they receive any rational explanation except that of phyſical connexion by deſcent in the ordinary way.

In calling your attention to this ſubject, I have preferred to lay before you a few well-aſcertained facts, rather than trouble you with a long liſt of opinions of many writers, for this is not a ſubject to be decided by authority. I would obſerve, however, that when we find theſe views adopted by men who have rejected the fancies of Lamarck, and of the author of the *Veſtiges of Creation*, by men of the higheſt intellectual powers, who have devoted their lives to the ſtudy of every branch of natural ſcience, it does appear to me to ſavour ſomewhat of preſumption on the part of dilettanti naturaliſts, who treat the ſubject with ridicule, and ignore all facts which do not accord with their own preconceived ideas or prejudices.

The queſtion of the origin of ſpecies is one of the moſt intereſting that can occupy the attention of the philoſophical naturaliſt, and it is impoſſible to peruſe the ſcientific literature of the day without obſerving the great influence already produced by Mr. Darwin's writings. Differences of opinion may exiſt as to details, but it is well known that the great majority of the moſt eminent European naturaliſts are agreed in the main point, that exiſting are the modified deſcendants of cloſely allied pre-exiſting ſpecies. Till lately this queſtion of the origin of ſpecies was apparently the one ſolitary exception to the reſult of all modern reſearch, viz., the conviction of the univerſal dominion of *law* and order, but it now aſſumes its proper place as a branch of true inductive ſcience.

The ſubjects to which I have referred in this neceſſarily imperfect ſketch may, at firſt ſight, appear to be but ſlightly connected; yet the origin and ſtructure of rocks, changes of climate, and the cauſes which have produced the wonderful variety of living beings by which we are ſurrounded, form but a part of the many branches of ſcience which all centre in geology; the true object of which, be it remembered, is not to diſcover the origin of things, but ſimply to aſcertain the hiſtory of the various changes that have taken place in organic and inorganic nature. One great leſſon to be learned from this ſtudy is the uniformity and permanence of the laws which govern the operations of nature. In the entire ſeries of rocks, from the moſt recent to the oldeſt known, there is nothing anomalous, nothing that may not be explained by proceſſes ſtill in operation. In the old ſtratified rocks ripple marks and "falſe-bedding" teach us that winds, waves, and varying currents played their part in the arrangement of ſand and mud as they do now, and even the direction of the driving rain may ſtill be ſeen in the ſharply defined impreſſions on many ſandſtones. The ſtudy of geology and the collateral ſciences has contributed greatly to ſtrengthen the concluſions to which all ſcientific opinion is now tending, viz., the *unity* of ſcience, and the uniformity and continuity of natural law; the reſult of every new phyſical diſcovery being to connect phenomena which were previouſly iſolated, and thus to reduce them to ſome ſingle principle or general law.

Such has been the reſult of the application of the inductive philoſophy to the ſtudy of natural phenomena. In the eloquent words of Macaulay, "It is philoſophy which never reſts, which has never attained, which is never perfect. Its law is progreſs. A point which yeſterday was inviſible is its goal to-day, and will be its ſtarting-point to-morrow."

It now only remains for me to thank you, gentlemen, with all ſincerity, for the cordial ſupport and co-operation which I have invariably received during the paſt year. To my fellow-officers, and eſpecially to our indefatigable ſecretary, I offer my warmeſt thanks; and to all of you I feel deeply indebted for the courteſy and kindneſs you have uniformly diſplayed towards me.

Our ſociety, though planted in a ſomewhat ungenial ſoil, is healthy and flouriſhing, and its future growth and progreſs is certain if each member will contribute in his own way to its ſupport and advancement. Up to the preſent time one of its moſt agreeable characteriſtics has been an entire abſence of thoſe wretched little perſonal jealouſies which have ruined ſo many other aſſociations. Whatever may be our ſhortcomings in other reſpects, we are at any rate free from that fatal defect; and with a little more ſyſtematic and original work on the part of our members, there is no reaſon why we ſhould not maintain a good poſition as a ſcientific ſociety: we are, I think, making fair progreſs, and on retiring from office, I have the ſatisfaction of knowing that my ſucceſſor is a warm and active friend of our cauſe, far more able than myſelf to preſide at our meetings, and whoſe chief characteriſtic is, that whatever he undertakes to do he does well.

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